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REPORT OF THE AMERICAN COMMITTEE ON ELECTROLYSIS, 1921

A REVIEW BY VICTOR B. PHILLIPS[1]

HISTORY OF THE COMMITTEE

The American Committee on Electrolysis was organized early in 1913, upon the initiative of the American Institute of Electrical Engineers. The purpose of the Committee was to study the subject of electrolysis "comprehensively, and endeavor, if possible, by co-operation" by the several national societies interested and "with other interested associations and corporations to gather and classify information, and if then found feasible to agree upon and recommend methods which without being financially prohibitive will nevertheless practically eliminate the damage from electrolysis."

The following bodies are represented on the Committee by three members each:

American Institute of Electrical Engineers
American Electric Railway Association
American Railway Engineering Association
National Electric Light Association
American Gas Association
Natural Gas Association of America
American Telephone and Telegraph Company
American Water Works Association
National Bureau of Standards

In October, 1916, the Committee published "A Preliminary Report Prepared for Submission to its Principals." This report was in the main a statement of the status of the art upon that date. It contained four sections prepared by as many sub-committees, dealing with the following subject matter:

I. Principles and Definitions
II. Methods of Making Electrolysis Surveys
III. American Practice
IV. European Practice

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The report was a compilation of methods, practices, and conditions, and included also to some extent such expressions of opinion and interpretation of the facts as could be agreed upon at that time. The report was not, however, in any sense the result of field research work by the Committee for the purpose of developing new facts regarding electrolysis and its mitigation.

Subsequent to the publication of its preliminary report, the activities of the American Committee on Electrolysis were interrupted by the war but were resumed early in 1919, at which time a new sub-committee was appointed, known as the Research Sub-committee, for the purpose of coöperating with the Bureau of Standards in conducting original research work. The earlier work of the Committee had demonstrated that there were fundamental differences of opinion as to the effectiveness of different methods of mitigation. One of these, and perhaps the most important, was pipe drainage. This in turn involved the question of joint corrosion and the Research Sub-committee forthwith undertook extensive investigations in many cities throughout the country for the purpose of determining upon the seriousness of joint corrosion and the conditions under which such corrosion took place. In the course of these investigations a great deal of valuable data was obtained, all of which was very thoroughly analyzed by the Research Sub-committee. From early in 1919 to date, the Research Sub-committee has actively prosecuted its investigations, and has held meetings as often as once a month.

The 1921 Report of the American Committee on Electrolysis supersedes the preliminary report in that it contains practically all of the subject matter contained in the earlier report and in addition contains the conclusions reached through the activities of the Research Sub-committee. The report represents the combined effort of all of the interests involved, including the Bureau of Standards and the unanimous opinion of the representatives of these different interests. The report is a very complete treatment of the subject and is in effect a treatise on electrolysis.

ABSTRACT OF 1921 REPORT

It is not possible within the limits of a review of this kind to completely abstract this comprehensive report. In lieu of this the principal differences between the 1916 and 1921 reports will be mentioned and the outstanding features of the latter report abstracted.

Chapter I, "Principles and Definitions" and Chapter IV, "European Practice" are substantially the same in both reports. On account of the war, European practice regarding electrolysis has not changed in any essential respect since the preliminary report was written. Chapter III, "Electrolysis Surveys" of the 1921 report contains a description of methods for determining the "leakage resistance between tracks and underground structures," or in other words, roadbed resistance. This resistance is a matter of first importance in track and roadbed construction. There is a rather wide difference in the roadbed resistance of the different types of construction which are now commonly used by electric railways. The higher resistance obtained by the use of wood ties with clean crushed stone, for example, substantially reduces the amount of stray current resulting from a given potential drop along the tracks, and consequently results in a saving in the cost of other mitigative measures.

Chapter II, "Design, Construction, Operation and Maintenance" of the 1921 report corresponds to Section III, "American Practice" of the 1916 report. The principal differences between the two reports are to be found in this chapter which is much more complete in the 1921 report, largely as a result of the investigations of the Research Sub-committee. This chapter contains a "Summary of Good Practice" which, in a space of eight pages, admirably but briefly sets forth the outstanding features of design and operation as regards both railways and affected structures, which today reflect the highest status of the art. This "Summary of Good Practice" constitutes a distinct contribution to the engineering profession and should prove of more than considerable value to the practical operating man who is confronted with the difficulties of electrolysis. This summary will be outlined in some detail.

The first section of the summary entitled "Railways" deals with the following subjects: (1) Track Construction and Bonding; (2) Track Insulation; (3) Reinforcement of Rail Conductivity; (4) Power Supply; (5) Interconnection of Tracks; (6) Insulated Negative Feeder System; (7) Three-Wire System; (8) Reversed Polarity Trolley System; (9) Periodic Reversal of Trolley Polarity; (10) Double Contact Conductor Systems; (11) Alternating Current Systems. The importance of making the tracks a continuous and low-resistance return circuit is set forth. This is accomplished by the use of heavy rails, properly bonded or welded joints, frequent cross-bonds, and jumpers around special work. The report states

"Roadbeds should be constructed with as high electrical resistance to earth as consistent with other considerations, special attention being given to keeping them dry by drainage. Where practicable, rails should be kept out of contact with the earth." With regard to the reinforcement of rail conductivity, the use of copper in parallel with tracks is shown to be uneconomical and the use of buried conductors to be undesirable because of reduced roadbed resistance. With regard to the reduction of stray currents by the proper design of the power distribution system of the electric railway, the report states,

(d) Numerous independent connections to the track for the return of current afford the most effective means of reducing high potential gradients and overall voltages and thereby limiting stray currents, and as many should be provided as consistent with good engineering and economic considerations.

This can be accomplished by the use of additional power supply stations, by the installation of insulated negative return feeders, or by the three-wire system wherein each car on the negative trolley becomes a point of return. Combinations of these may also be employed.

(e) The most generally satisfactory method of increasing the number of independent return points on a track system is by the use of additional substations and the tendency of railway practice is now in this direction.

(f) Considerable progress has been made in recent years in the development of automatic, semi-automatic, and remote control substations and these are now being used both on interurban lines and for city service. The economies attending such substations make possible a greater number of feeding points than can economically be supplied through manually operated stations.

(g) By employing the maximum number of substations consistent with economy, rather than the minimum number, stray currents will be greatly reduced.

The relatively high cost of returning power over an insulated negative feeder system as compared to the track and ground return is pointed out.

Under the heading "Affected Structures," the summary deals with the following subjects: (1) Location with Respect to Tracks; (2) Avoidance of Contact of Cables with Pipes and Other Structures; (3) Conduit Construction; (4) Insulating Joints in Cable Sheaths; (5) Surface Insulation of Pipes and Cables; (6) Insulating Joints in Pipes; (7) Shielding. It is pointed out that

On streets in positive areas where car tracks exist gas and water mains are sometimes installed on both sides of the streets. Such construction permits the use of shorter services and obviates the necessity for placing service pipes under tracks.

Of particular interest to pipe-owning interests is the Committee's conclusion regarding the use of insulating joints:

(a) Insulating or high resistance joints, such as those of the Dresser type or cement joints, if used throughout a pipe line at frequent intervals, or at specially selected locations may afford substantial protection against electrolysis. This practice relates particularly to gas and oil pipes.

(b) It is sometimes permissible to use comparatively few insulating joints if care is taken to see that the flow of current on the pipe is practically eliminated.

(c) Insulating joints are often installed in service pipes for the purpose of preventing the interchange of current between pipe systems.

The third section of the summary "Interconnection of Affected Structures and Railway Return Circuit" deals with (1) Cable Drainage and (2) Pipe Drainage. The essential difference between cables and pipes in so far as electrical drainage is concerned lies in the electrical continuity of cables and in the occurrence of high resistance joints in pipes. The rules governing the employment of cable drainage are set forth in considerable detail. With regard to pipe drainage, it is worth while to quote from the summary in full.

(a) There are wide differences of opinion among competent engineers who have studied pipe drainage, as to it adaptability to various conditions. Numerous questions are involved in regard to which there is not sufficient information available at the present time to permit the drawing of accurate conclusions, and for this reason this subject is being investigated by the Research Sub-Committee of the American Committee on Electrolysis. There are, however, certain objections to the use of pipe drainage which are discussed in this report and which should be carefully considered before employing it.

(b) Pipe drainage is in use more or less on water systems and to a limited extent on gas systems.

(c) As a method of mitigation, drainage is not so well adapted to pipes as to cable sheaths.

(d) High resistance joints are prevalent in all jointed pipe lines and they greatly complicate the application of drainage.

(e) To lower the potential of a jointed piping system below that of the surrounding earth, it is usually necessary to extend the drainage conductors over a considerable area and connect to the pipes at numerous locations.

(f) Corrosion at high resistance joints in pipe lines carrying current may occur unless the pipe on both sides of the joint is maintained negative or neutral to the adjacent earth, in which case no corrosion will occur.

(g) Drainage generally increases the current flow on pipes and such current increases the hazard from oil and gas ignitions and explosions.

(h) In small towns on interurban railways pipe drainage is less objectionable than in urban districts where complicated pipe networks exist.

(i) Drainage of a large network of pipes should be used only as an auxiliary to a railway system, properly designed and maintained from the electrolysis standpoint. When so used it should be installed and maintained under competent supervision.

It is perhaps desirable to repeat here that the foregoing is in no sense a comprehensive abstract of the report and that only a few of the outstanding questions dealt with in the report have been mentioned here. It is not putting it too strongly to say that everyone interested in the involved subject of electrolysis mitigation should find this 1921 Report of the American Committee on Electrolysis profitable reading and of great practical value.

Note: Copies of the Report may be had from the American Water Works Association, 153 West 71st Street, New York City, price $1.00, postage prepaid.